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मानक

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Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

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“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 15886 (2010): ROAD VEHICLES – BATTERY OPERATED VEHICLES
– CODE OF PRACTICE [TED 26: Automotive vehicles on NCES]



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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

सड़क वाहन — बैटरी चालित वाहन — रीति संहिता

Indian Standard

ROAD VEHICLES — BATTERY OPERATED
VEHICLES — CODE OF PRACTICE

ICS 43.120

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Vehicles Running on Non-conventional Energy Sources Sectional Committee had been approved by the Transport Engineering Division Council.

In the formulation of this standard, assistance has been derived from:

AIS 038	Battery operated vehicles — Requirements for construction and functional safety
AIS 039	Battery operated vehicles — Measurement of electrical energy consumption
AIS 040	Battery operated vehicles — Method of measuring the range
AIS 041	Battery operated vehicles — Measurement of net power and the maximum 30 minute power and speed
AIS-049	Battery operated vehicles — CMVR type approval for battery operated vehicles
IEC 60050-826	International electro technical vocabulary—Part 826: Electrical installations
IEC 61140 : 2001	Protection against electric shock — Common aspects for installation and equipment,
Doc No. MoSRT&H/	issued by the Ministry of Shipping, Road Transport and Highways
CMVR/TAP-115/116:	
Issue No. 3	

Following documents may be referred for latest update on statutory requirements related to use of CNG fuel system in Internal Combustion Engine Vehicles:

Central Motor Vehicle Rules, 1989 (CMVR) (As amended from time-to-time)

Motor Vehicle Act, 1988 (MVA) (As amended from time-to-time)

The composition of the Committee responsible for the formulation of this standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ROAD VEHICLES — BATTERY OPERATED VEHICLES — CODE OF PRACTICE

1 SCOPE

This standard provides guidelines for construction, functional safety and test methods for battery operated automotive vehicles.

NOTE — In addition to above battery operated vehicles shall comply with various performance and safety related tests, for example, brake, gradeability, pass by noise measurement, installation and performance requirements of lighting and light signaling devices, electromagnetic radiation, etc, as applicable to the vehicle category as per *Central Motor Vehicle Rules*, 1989 (as amended from time-to-time).

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
1293 : 1988	Plugs and socket outlet of 250 volts and rated current up to 16 A (<i>second revision</i>)
9457 : 1980	Code of practice for safety colours and safety signs
12063 : 1987	Classification of degrees of protection provided by enclosures of electrical equipment
IS/IEC 309-2 : 1989	Plugs, socket-outlets and couplers for industrial purposes: Part 2 Dimensional interchangeability requirements for pin and contact tube accessories

3 TERMS AND DEFINITIONS

For the purpose of this standard, the following terms and definitions shall apply:

3.1 Access Probe — A test probe simulating in a conventional manner a part of a person or a tool, or the like, held by a person to verify adequate clearance from hazardous part.

3.2 Active Driving Possible Mode — A vehicle mode when applications of pressure to the accelerator pedal

(or activation of an equivalent control) will cause the drive train to move the vehicle.

3.3 Adequate Clearance for Protection Against Access to Hazardous Parts — A distance to prevent contact or approach of an access probe to a hazardous part.

3.4 Approval of a Type of Battery Electric Road Vehicle — The approval of a type of electric vehicle regarding construction and functional safety requirements specific to the use of electric energy.

3.5 Auxiliary Battery — The battery unit whose reserve of energy is used only for the auxiliary network supply.

3.6 Auxiliary Network — The assembly of auxiliary electric equipment with similar functions to the one used on vehicles equipped with an internal combustion engine.

3.7 Battery Electric Road Vehicle — A vehicle with bodywork intended for road use, powered exclusively by an electric motor whose traction energy is supplied exclusively by a traction battery installed in the vehicle.

3.8 Battery Module — The smallest single energy storage consisting of one cell or an assembly of cells, electrically connected in serial or in parallel, placed in one container and mechanically associated.

3.9 Battery Pack — A single mechanical assembly comprising of battery modules and retaining frames or trays. A vehicle may have one or several, or no battery pack.

3.10 Coupling System — All the parts used to connect the vehicle to an external electric power supply (alternative or direct current supply).

3.11 Degree of Protection — The extent of protection provided by an enclosure against access to hazardous parts against ingress of solid foreign objects and/or against ingress of water and verified by standardized test methods.

3.12 Direct Contact — Contact of persons (or livestock) with the live parts.

NOTE — This IEV definition is given for information. In this Standard 'Direct contact' is replaced by 'Access to hazardous parts'.

3.13 Drive Direction Controls Unit — A specific device physically actuated by the driver in order to select the drive direction (forward or backward), in which the vehicle will travel if the accelerator is actuated.

3.14 Drive Train — Specific components of power train, such as the traction motors, electronic control of the traction motor, the associated wiring harness and connectors.

3.15 Electrical Chassis — A set made of conductive parts electrically linked together, and all other conductive parts electrically linked to them, whose potential is taken as a reference.

3.16 Electrical Circuit — An assembly of connected live parts through which an electrical current is designed to pass in normal operation conditions.

3.17 Electric Regenerative Brake Control — A device, which modulates the action of the electric regenerative braking system.

3.18 Electric Regenerative Braking System — A braking system, which allows the use of the vehicle's drive motor(s) to convert the vehicle's kinetic energy into electrical energy during deceleration.

3.19 Electric Regenerative Braking System of Category A — An electric regenerative braking system, which is not part of the service braking system.

3.20 Electric Regenerative Braking System of Category B — An electric regenerative braking system, which is part of the service braking system.

3.21 Electronic Converter — An apparatus allowing the control and/or transfer of electric energy.

3.22 Enclosure — A part providing protection of equipment against certain external influences and, in any direction, protection against direct contact.

NOTE — This definition taken from the existing International Electrotechnical Vocabulary needs the following explanations under the scope of this standard:

- a) Enclosures provide protection of persons (or livestock) against access to hazardous parts.
- b) Barriers, shapes of openings or any other means — whether attached to the enclosure or formed by the enclosed equipment — suitable to prevent or limit the penetration of the specified test probes are considered as a part of the enclosure, except when they can be removed without the use of a key or tool.

3.23 Exposed Conductive Part — Any conductive part, which can readily be touched and which is not normally alive, but which may become electrically energized under fault conditions.

3.24 Hazardous Live Part — A live part, which, under certain conditions of external influences can give an electric shock.

3.25 Hazardous Mechanical Part — A moving part, other than a smooth rotating shaft, that is hazardous to touch.

3.26 Hazardous Part — A part that is hazardous to approach or touch.

3.27 Indirect Contact — Contact of persons or livestock with exposed conductive parts.

3.28 IP Code — A coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water to give additional information in connection with such protection.

3.29 Key — Any device designed and constructed to provide a method of operating a locking system, which is designed and constructed to be operated only by that device.

3.30 Live Parts — Any conductor or conductive part(s) intended to be electrically energized in normal use.

3.31 Maximum Mass — The technically permissible maximum mass declared by the manufacturer, also referred as GVW.

3.32 Maximum 30 min Power — The maximum net power at wheels of an electric drive train at rated voltage, which drive train can deliver over a period of 30 min as an average.

3.33 Maximum 30 min Speed of the Vehicle — The maximum speed at which the vehicle runs continuously for 30 min, with the battery in the fully charged condition. Maximum thirty-minute speed of the vehicle can be measured on the chassis dynamometer by running the vehicle with the battery in full charged condition. The maximum speed at which the vehicle runs continuously for 30 min is the maximum thirty-minute speed of the vehicle.

3.34 Normal Voltage — The root-mean-square (r.m.s) value of the voltage specified by the manufacturer, for which the electrical circuit is designed and to which its characteristics are referred.

3.35 Object Probe — A test probe simulating a solid foreign object to verify the possibility of ingress into an enclosure.

3.36 Off-board Charger — An energy electronic converter used for charging battery from an external power supply (mains network) and which is not the integral part of the vehicle.

3.37 On-board Charger — An energy electronic converter linked by construction to the vehicle and used for charging the traction battery from an external electric power supply (mains network).

3.38 Opening — A gap or aperture in an enclosure, which exists or may be formed by the application of a test probe at the specified force.

3.39 Passenger and Load Compartment — The space in the vehicle for occupant accommodation and bounded by the roof, floor, side walls, outside glazing, front bulkhead and the plane of the rear-seat back support and eventually the partition between it and the compartment(s) containing the battery modules.

3.40 Power Train — The electrical circuit including:

- a) Traction battery;
- b) Electronic converters (on-board charger, electronic control of the traction motor, dc/dc converter, etc);
- c) Traction motors, the associated wiring harness, connectors, etc;
- d) Charging circuit; and
- e) Power auxiliary equipment (for example heating, defrosting and power steering).

3.41 Reference Mass — The unladen mass of the vehicle increased by a figure of 75 percent of the payload for vehicles with GVW up to 7.5 tonne.

3.42 Traction Battery — The assembly of all battery modules, which are electrically connected, for the supply of energy of the power circuit.

3.43 Unladen Mass — The mass of the vehicle in running order without driver, crew, passengers or load, but with the fuel tank full (if any), cooling liquid, service and traction batteries, oils, onboard charger, portable charger, tools and spare wheel, whatever is appropriate for the vehicle considered and if provided by the manufacturer of the vehicle.

3.44 Vehicle Type — Battery electric road vehicles, which do not differ in such essential aspects as — dimensions, structure, shape and nature of constituting materials installation of the power system components, battery or battery packs, tyres, unladen mass, nature and type of electric and electronic components.

3.45 Working Voltage — The highest root-mean-square (r.m.s.) value of an electrical circuit voltage, specified by the manufacturer, which may occur across any insulation, in open circuit conditions or under normal driving and servicing conditions.

3.46 Net Power — The power obtained at the wheels of electric vehicle when tested on chassis dynamometer at corresponding vehicle speed at reference atmospheric conditions.

4 CONSTRUCTION REQUIREMENTS

4.1 Traction Battery

Installation of the traction battery in the vehicle shall

not allow any potential dangerous accumulation of gases. Battery compartments containing battery modules, which may produce hazardous gases, shall be safely ventilated. Details of ventilation provided by manufacturer shall be verified by the test agency at the time of type approval.

The traction battery and the power train shall be protected by properly rated fuse or circuit breakers. The components on the vehicle shall be as per the specifications declared by the manufacturer as given in Annex A.

4.2 Mounting of Batteries

The mounting of batteries in the battery operated vehicle shall be such that batteries/battery packs are not displaced from their place and there is no spillage of electrolyte when vehicle is driven on gradient or any other type of road. This condition shall be deemed to be satisfied, if no spillage of electrolyte is observed while conducting various tests for type approval.

4.2.1 Creepage Distance for Traction Batteries

This clause deals with additional leakage current hazard between the connection terminals of a traction battery module including any conductive fittings attached to them and any conductive parts, due to the risk of electrolyte spillage or leakage in normal operating conditions.

It does not apply to traction batteries, for which electrolyte leakage will not occur under normal operating conditions, for example, sealed traction batteries.

The minimum creepage distance shall be as follows:

- a) In the case of a creepage distance between two battery connection terminals:

$$d \geq 0.25 U + 5$$

where

d = creepage distance measured on the tested traction battery, in mm, and

U = nominal voltage between the two battery connection terminals, in V.

- b) In the case of creepage distance between live parts and the electrical chassis:

$$d \geq 0.125 U + 5$$

where

d = creepage distance measured between the live part and the electrical chassis, in mm; and

U = nominal voltage between the two battery connection terminals, in V.

4.3 Protection Against Electric Shock

4.3.1 Protection Against Direct Contact with Live Parts of the Power Train

4.3.1.1 If the working voltage of the electric circuit is lower than 60 V dc or 25 V ac, no protection is required.

4.3.1.2 Direct contact with live parts of the electrical power train whose maximum voltage is at least 60 V dc or 25 V ac shall be prevented either by insulation or by the use of covers, protection grills, perforated metal sheets, etc. These protections shall be reliably secured and shall be mechanically resistant. They shall not be able to be opened, disassembled or removed without the use of tools.

4.3.1.3 Live parts in passenger and load compartments, shall be protected by enclosures having a protection degree of at least IPXXD.

4.3.1.4 Enclosures in other areas of the vehicle shall have a protection degree of at least IPXXB.

4.3.1.5 In the drive-train compartment the access to live parts shall only be possible with voluntary action, that is, with the use of physical tools like screwdriver to open the same.

4.3.1.6 After opening the cover, the access to the parts of the coupling system shall be protected with IPXXB protection.

4.3.1.7 Protection degrees IPXXB and IPXXD are related respectively to the contact of a jointed test finger and a test wire with hazardous parts. The parts shall be tested for protection against direct contacts under voltage as per test procedure given in Annex B.

4.3.1.8 Vehicle markings

Protection covers of live parts described in **4.3.1.2** shall be marked by a symbol as shown in Fig.1 (see IS 9457).

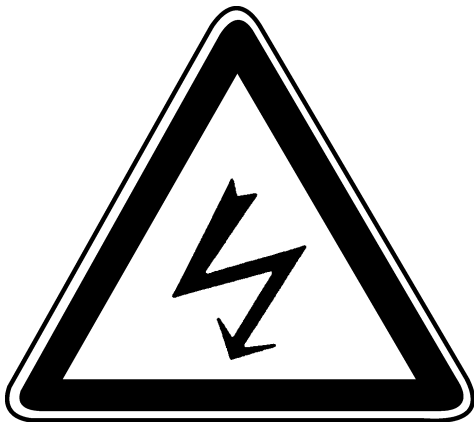


FIG. 1 SYMBOL FOR INDICATION OF VOLTAGE

4.3.2 Protection Against Indirect Contacts with Exposed Conductive Parts of the Power Train

4.3.2.1 If the working voltage of the electric circuit is lower than 60 V dc or 25 V ac, no protection is required.

4.3.2.2 The design, installation and manufacture of electric material shall be such that insulation failures are avoided. This shall be considered as a design guideline.

4.3.2.3 Insulation used shall ensure protection against indirect contacts and additionally, the exposed conductive parts of the on-board equipment shall be electrically connected together. This potential equalization is obtained by connecting the exposed conductive parts together either by a protective conductor, for example, wire, ground truss, or directly by the vehicle metallic chassis. Two exposed conductive parts welded together are considered as having no discontinuity points. If there is some discontinuity, this point shall be by-passed by potential equalization.

4.3.3 Insulation Resistance of Traction Batteries

4.3.3.1 The insulation resistance measurement is performed after maintaining the vehicle for a conditioning time of 8 h with the following conditions:

- a) Temperature: 20-35°C
- b) Humidity: 90^{+10}_{-5} percent

4.3.3.2 Using a measuring dc voltage equal to the nominal voltage of the traction battery, insulation resistances between any exposed conductive part and each polarity of the traction battery when tested as per Annex C shall have a minimum value of 500 Ω /V of the nominal voltage.

4.3.3.3 Resistance of the protective conductor

The potential equalization resistance between any two exposed conductive parts shall be lower than 0.1 ohm. This test shall be performed by a current of at least 0.2 A after conditioning as mentioned in **4.3.3.1**.

4.3.4 Connection of the Vehicle to the Mains Network

4.3.4.1 In no case the vehicle shall be capable to move by its own means when it is electrically connected to an energy supply network or to an off-board charger.

4.3.4.2 The components used when charging the battery from an external source shall allow the charging current to be cut without physical damage in case of disconnection.

This will be checked by reconnection and ensuring that there is no fault in the system.

4.3.4.3 The coupling system parts likely to be live shall be protected against any direct contact in all operating conditions.

4.3.4.4 For on-board charger all exposed conductive parts, shall be electrically linked through a conducting wire plugged to earth when charging.

5 FUNCTIONAL SAFETY REQUIREMENTS

5.1 Power 'ON' Procedure

The power 'ON' procedure shall be applied *via* a key switch. It shall not be possible to remove this key in any position that energizes the drive train or makes active driving possible.

5.2 Running and Stopping Conditions

5.2.1 At least a momentary optical or audible indication shall be given to the driver when:

- a) the vehicle is in active driving possible mode, or
- b) at least one further action is required to place the vehicle in active driving possible mode.

There shall also be an indication to the driver when state of charge of the battery reaches a level where re-charging is recommended. When this condition is reached, the user shall be warned to perceive this situation quickly enough to be able to drive the vehicle, on its own power, at least out of the traffic zone. The manufacturers shall provide the information regarding the state of charge after the warning indication comes on.

There shall be an additional indication indicating that the state of charge of battery has reached a level at which driving the vehicle further may cause damage to the battery. This indication is not necessary, if the emergency power reduction (*see* 5.4) takes into account this state of charge of battery. This shall be declared by the manufacturer.

5.2.2 Unintentional acceleration, deceleration and reversal of the drive train shall be prevented. In particular, a failure (for example, in the power train) shall not cause more than 0.1 m movement of a standing un-braked vehicle on level road.

5.2.3 When leaving the vehicle, the driver shall be informed by an optical or audible signal if the drive-train is still in the active driving possible mode.

This condition shall be deemed to be satisfied if the indication specified in 5.2.1(a) is not momentary and continues to be displayed.

5.3 Reversing

5.3.1 Reversing shall be possible only after a specific action. This action shall require either,

- a) the combination of two different actuation's for example, gear and clutch; or

- b) an electric switch, which allows reverse to be engaged only when the vehicle is moving at a forward speed not exceeding 5 km/h. It shall not be possible for the vehicle to move in reverse direction, if the switch is operated when the vehicle is moving forward at a speed beyond 5 km/h.

The device shall have only one stable position for achieving the reverse motion of the vehicle.

5.3.2 The state of the drive direction control unit shall be easily identifiable.

5.3.3 The maximum speed achieved in reverse direction shall not be more than 20 km/h.

5.4 Emergency Power Reduction

If the vehicle is equipped with a device to limit the performance in an emergency (for example, overheating of a component) the user shall be informed by an obvious signal indicating state of limited performance.

5.5 On-board Charger

5.5.1 The charger socket of the on-board charger shall have the time rating in addition to the ampere rating. The time rating shall be 5 h or the recommended time for charging fully discharged battery, whichever is higher. The charging socket shall be capable of withstanding the in-rush current and the continuous current rating of the socket shall be commensurate with the charging current.

5.5.2 The rated maximum and continuous duty specification of the power socket in terms of current, voltage, etc, shall be declared by the manufacturer. These values shall be compatible with the specification of the on-board charger. The manufacturer shall certify compliance to these parameters. The mains plug shall be compatible for use with sockets as per IS 1293 or IS/IEC 309-2 or any other equivalent.

5.5.3 On-board charger shall have soft start facility, limiting the initial in-rush current. The manufacturer shall specify the initial rush current and the time duration from the mains to the charger.

5.5.4 The charger shall have at least indication of 'charging in process' and 'charging is over'. These conditions are deemed to be satisfied, if the indicator for state of charge of battery provided on vehicle takes care of this requirement.

5.6 On-board Indicators

All the indicators meant for the driver referred above shall be suitably located so as to be visible to the driver easily (for example, on the dashboard).

Additionally, the battery-operated vehicle shall have the battery state of charge indicator.

For additional indications of temperatures like motor temperature, the existing water temperature symbol may be suitably modified.

5.7 Protection Against Water Effects

The test as per 5.7.1, 5.7.2 and 5.7.3 shall be performed. After each exposure (vehicles still wet), the vehicle shall then comply with the insulation resistance test as in 4.3.3.2, at normal environmental condition, but keeping the power equipment connected to the traction battery (main switch closed), with the requirements of at least 100 Ω/V .

5.7.1 Washing

This test is intended to simulate a normal washing of battery operated vehicles, but not specific cleaning using high water pressure or underbody washing. The vehicle manufacturer shall specify detailed conditions for such specific cleaning or washing in the owner's manual. The critical areas of the vehicle regarding this test are border lines, that is, a seal of two parts as flaps, glass seals, outline of opening parts, outline of front grille, seals of lamps.

In the case of open vehicles such as 3-wheelers without doors and windows, or 2-wheelers, etc, the manufacturer shall specify the procedure for normal washing also. In such cases, the washing test shall be conducted by taking into account the above recommendation.

The test uses a hose nozzle according to IPX5 as specified in IS 12063 (see Annex D). Using fresh water with a flow rate of 12.5 l/min, all border lines shall be exposed and followed in all directions with the water stream at a speed rate of 0.1 m/s, keeping a distance of 3 m between the nozzle aperture and the border line.

5.7.2 Flooding

This test is intended to simulate the driving of an electric road vehicle on flooded streets or in water puddles.

The vehicle shall be driven in a wade pool, 10 cm in depth, over a distance of 500 m at a speed of 20 km/h resulting in a time of approximately 1.5 min.

If the wade pool used is less than 500 m in length, so that it has to be driven through several times, the total time including the periods outside the wade pool shall be less than 10 min.

5.7.3 Heavy Rainstorm

This test is intended to simulate a sudden heavy

rainstorm, for example a thunderstorm, when opening parts especially to access to the passenger, load and motor compartments are open except those requiring one or more tools.

In case of voltage Class B equipment shielded from exposure to water, this test of the whole vehicle may be replaced by equivalent tests on the components individually.

The critical areas of the vehicle regarding this test are those accessible with opened opening parts.

This test uses a spray nozzle according to IPX3 as specified in IS 12063.

Using fresh water with a flow rate of 10 l/min, all surfaces with normally open opening parts shall be exposed for 5 min, possibly through a regular movement of the spray nozzle.

NOTE — Voltage Class B equipment is an equipment with nominal voltage (U)

dc: $60\text{ V} < U \leq 1\,500\text{ V}$

ac: $25\text{ V}_{\text{rms}} < U \leq 1\,000\text{ V}_{\text{rms}}$ and frequency 15 to 150 Hz

6 METHOD OF MEASURING THE ELECTRIC ENERGY CONSUMPTION

The measurement of the electrical energy consumption shall be conducted as per the procedure prescribed below. This is also used to verify the performance of the vehicle with that declared by the manufacturer.

6.1 Vehicle Preparation

6.1.1 Condition of the Vehicle

6.1.1.1 The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer when the tyres are set at the ambient temperature. Higher inflation in pressure is permitted as per 6.1.3 of Chapter-3 of Part-III of MoSRT&H/CMVR/TAP-115/116: Issue No. 3. The viscosity of the oils for the mechanical moving parts shall conform to the specifications of the vehicle manufacturer. The lighting, light-signaling and auxiliary devices shall be off, except those required for testing and usual daytime operation of the vehicle.

6.1.1.2 All energy storage systems available for other than traction purpose (electric, hydraulic, pneumatic, etc) shall be charged up to their maximum level specified by the manufacturer.

6.1.1.3 The first charging of the battery shall be carried out as per 6.1.2, if not already done.

6.1.1.4 If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the vehicle manufacturer in order to keep the temperature of the battery in the normal

operating range. The vehicle shall have undergone at least 300 km or as specified by the manufacturer during the seven days before the test with those batteries that are installed in the test vehicle. This condition can be waived on request of the vehicle manufacturer.

6.1.2 Initial Charge of the Battery

Charging the battery consists of the following procedures.

NOTE — 'Initial charge of the battery' applies to the first charge of the battery, at the reception of the vehicle. In case of several combined tests or measurements, carried out consecutively, the first charge carried out shall be an initial charge of the battery and the following may be done in accordance with the normal charge procedure.

6.1.2.1 Discharge of the battery

The procedure starts with the discharge of the battery of the vehicle while driving (on the test track, on a chassis, dynamometer, etc) at a steady speed of 70 ± 5 percent from the maximum 30 min speed of the vehicle. Stopping of the discharge occurs,

- when the vehicle is not able to run at 65 percent of the maximum 30 min speed; or
- when an indication to stop the vehicle is given to the driver by the standard on-board instrumentation; or
- after covering the distance of 100 km.

6.1.2.2 Application of a normal charge

The battery shall be charged according to the following procedure.

6.1.2.2.1 Normal charge procedure

The charge is carried out,

- with the on-board charger, if fitted;
- with an external charger recommended by the manufacturer, the connection being made with the domestic plug whose pattern has been recommended by the manufacturer; and
- in an ambient temperature.

The procedure excludes all type of special charges that could be manually initiated like, for instance, the equalization charges or the servicing charges. The vehicle manufacturer shall be in a position to attest that during the test, a special charge procedure has not occurred.

6.1.2.2.2 End of charge criteria

The end of charge criteria corresponds to a charging time of 12 h except, if a clear indication is given to the driver by the standard instrumentation that the battery is not yet fully charged or as specified by the manufacturer.

In this case

$$\text{Maximum time} = \frac{\text{Claimed battery capacity (Wh)}}{\text{Mains power supply (W)}}$$

where

W = maximum power of the charger as specified by the manufacturer.

6.2 Test Conditions

Test shall be conducted at temperature between 20 °C and 40 °C.

The battery capacity shall be corrected to 27° C based on the following formula:

$$\text{Capacity at } 27^\circ \text{C} = C_t + [C_t \times R \times (27 - t)/100]$$

where

C_t = observed capacity at $t^\circ \text{C}$,

R = variation factor chosen from Table 1, and

t = average temperature during entire test (add temperature on hourly basis during discharge and divide by number of readings).

Table 1 Variation Factor

Sl No.	Discharge Rate	Factor for Variation in Capacity per °C, Percentage R
(1)	(2)	(3)
i)	C_{10}	0.43
ii)	C_9	0.45
iii)	C_8	0.47
iv)	C_7	0.50
v)	C_6	0.54
vi)	C_5	0.58
vii)	C_4	0.62
viii)	C_3	0.68
ix)	C_2	0.76
x)	C_1	0.90

6.3 Test Procedure

6.3.1 Test Sequence

6.3.1.1 The driving cycle shall be the Indian Driving Cycle (IDC) as given in Annexure-II of CMVR, for all vehicles other than 4-wheeled vehicles with maximum speed exceeding 80 km/h.

6.3.1.2 The driving cycle shall be Part-I of the modified Indian Driving Cycle (IDC) as given in Annexure-IV B of CMVR for 4-wheeled vehicles with maximum speed exceeding 80 km/h.

6.3.1.3 In cases where the vehicle does not reach the required acceleration during driving, the accelerator control shall remain fully activated until the reference curve has been reached again.

6.3.2 Power Setting of the Chassis Dynamometer

The procedure prescribed in the Doc No. MoSRT&H/CMVR/TAP-115/116: Issue No. 3 shall be adopted. The decision taken in the Standing Committee on Emission (SCOE) shall be followed for the same. Reference mass shall be taken as defined in 3.4.1.

6.3.3 Test Method

6.3.3.1 Principle

The test method described hereafter permits to measure the electric energy consumption expressed in Wh/km.

6.3.3.2 Parameters, Units and Accuracy of Measurements

Parameter	Unit	Accuracy	Resolution
Time	s	± 0.1 s	0.1 s
Distance	m	± 1 m	1 m
Speed	km/h	± 1 km/h	1 km/h
Mass	kg	± 20 kg ¹⁾	1 kg
Energy	Wh	± 0.2 percent	Class 0.2 s

¹⁾ In the case of 2-wheelers, the accuracy is ± 2 percent.

6.4 Application of the Cycle and Measurement of the Distance

6.4.1 The time at the end of charging t_0 (plug off) is reported.

6.4.2 The chassis dynamometer shall be set as per the settings in 6.3.2. Starting within 4 h from t_0 , 36 cycles of IDC (of 108 s duration each) or 2 cycles of modified IDC (of 1 220 s duration each) as applicable (see 6.3.1.1 or 6.3.1.2) are run. At the end, the covered distance (D) in km is recorded.

6.4.3 Charge of the Battery

The vehicle shall be connected to the mains within 30 min after the conclusion of the driving cycle. The vehicle shall be charged according to normal charge procedure (see 6.1.2.2.1). The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy E delivered from the mains as well as its duration. Charging is stopped after 24 h from the previous end of charging time t_0 .

NOTE — In case of any power disruptions during charging, the 24 h period shall be exceeded according to the disruption duration. The maximum total power disruption of 30 min duration is allowed irrespective of the number of failures. Validity of the charge shall be discussed between the technical services of the approval laboratory and the vehicle's manufacturer.

6.4.4 Electric Energy Consumption Calculation

The energy E in Wh, and charging time measurements

shall be recorded in the test report. The electric energy consumption is defined by the formula:

$$C = E/D$$

where C is expressed, in Wh/km, and rounded off to the nearest whole number, E is Wh and D is the range, in km.

6.5 Interpretation of Results

6.5.1 The electric energy consumption, adopted as the type approved vehicle, shall be the value declared by the manufacturer if the value measured during testing does not exceed the declared value by more than 4 percent. The measured value can be lower without any limitations.

6.5.2 If the measured value of energy consumption exceeds the manufacturer's declared value by more than 4 percent then another test shall be carried out on the same vehicle. When the average of the two test results does not exceed the manufacturer's declared value, by more than 4 percent then the value declared by the manufacturer shall be taken as the type approval value.

6.5.3 If the average still exceeds the declared value by more than 4 percent, a final test is run on the same vehicle. The average of the three tests is then taken as the type approval value.

6.6 Test Results

The result of the electric energy consumption may be expressed in Wh/km rounded off to the nearest whole number.

7 METHOD OF MEASURING THE RANGE

The test method described hereafter specifies method for measurement of range of battery operated vehicles (BoVs), expressed, in km.

7.1 Vehicle Preparation

Vehicle preparation shall be as per details given in 6.1.

7.2 Test Conditions

All the tests shall be conducted in ambient conditions.

7.2.1 Test Procedure

The test sequence as per the details given in 6.3.1.

7.2.2 Power setting of the chassis dynamometer shall be as per the details given in 6.3.2.

7.3 Test Method

7.3.1 Principle

The test method described hereafter permits to measure the range of the battery operated vehicle expressed, in km

7.3.2 Parameters, units and accuracy of measurements shall be as per **6.3.3.2**.

7.3.3 Operating Modes

The test method includes the following steps:

- a) Initial charge of the battery as described in **6.1.2**, and
- b) Application of the cycle and measurement of the range.

Between the steps, if the vehicle has to be moved, it is pushed to the following test area (without regenerative charging).

7.3.4 The first charge of the battery need not be carried out, if the vehicle manufacturer has certified that manufacturer has carried out the same.

7.3.5 The application of the cycle specified in above can be started if the vehicle manufacturer certifies that the battery is fully charged. If not, the charging procedure as per **6.1.2** shall be followed.

7.4 Application of the Cycle and Measurement of the Range

The test sequence shall be followed as per **6.3.1**.

The end of test criteria shall be when the vehicle is not able to meet the target curve up to 85 percent of the maximum speed of the driving cycle or 85 percent of the maximum speed of the vehicle, whichever is less or when the on-board indication is given to the driver to stop the vehicle, whichever occurs first.

To respect human needs, up to three interruptions are permitted between test sequences of not more than 15 min in total.

At the end, measured distance covered in km is the range of the electric vehicle.

7.5 Test Result

The test result of the range test may be expressed in kilometre (km), rounded off to the nearest whole number.

Observed value shall be within 10 percent of the declared value by the manufacturer. If it is not so, the second test shall be carried out using the same procedure. The result will be the average of two tests.

In case the difference between the two test readings is felt to be substantial, test will be repeated as agreed between the manufacturer and test agency.

8 MEASUREMENT OF NET POWER AND THE MAXIMUM 30 min POWER AND SPEED

The tests specified in this clause applies to the

representation of the curve as a function of motor speed and the power at full load indicated by the manufacturer for electric drive trains and the maximum 30 minutes power of electric drive trains intended for the propulsion of battery operated vehicles.

This also applies to measurement of the 30 min maximum speed of the battery operated vehicle.

8.1 Vehicle Preparation

8.1.1 Vehicle preparation shall be as per details given in **6.1**.

8.1.2 In addition, the battery-operated vehicle shall be conditioned at a temperature between 20 °C to 40 °C for minimum of 2 h before start of net power measurement test and for minimum of four hours before start of maximum 30-minute power test.

8.2 Test Conditions

8.2.1 The test shall be conducted at temperature between 20° C and 40° C.

8.2.2 The test for motor power may be conducted by testing the drive train using a bench dynamometer or by testing the vehicle using a chassis dynamometer.

8.2.3 Testing on Bench Dynamometer

8.2.3.1 While testing the motor power train using bench dynamometer, the auxiliaries necessary for the drive train operation in the intended application as listed below shall be installed in the same position as in the vehicle.

- a) Speed variator and control device
- b) *Liquid cooling*:
 - 1) Radiator
 - 2) Fan
 - 3) Fan cowl
 - 4) Pump
 - 5) Thermostat
- c) *Air cooling*:
 - 1) Air filter
 - 2) Cowl
 - 3) Blower
 - 4) Temperature adjustment system
- d) Electric equipment
- e) Bench test auxiliary fan, if necessary

NOTES

1 The radiator, the fan, the fan cowl, the water pump and the thermostat shall be located on the test bench in the same relative position as on the vehicle. The cooling-liquid circulation shall be activated by the drive-train water pump only. Cooling of the liquid may be produced either by the drive train radiator, or by an external circuit, provided that the pressure loss of this

circuit and the pressure at the pump inlet remain substantially the same as those of the drive-train cooling system. The radiator shutter, if any, shall be in the open position. Where the fan, radiator and fan cowl cannot conveniently be fitted for the bench test, the power absorbed by the fan when separately mounted in its correct position in relation to the radiator and cowl (if used), shall be determined at the speed corresponding to the motor speeds used for measurement of the motor power either by calculation from standard characteristics or by practical tests. This power, corrected to the standard atmospheric conditions should be deducted from the correct power.

2 Where a disconnectable or progressive fan or blower is incorporated, the test should be carried out with the disconnected fan (or blower) disconnected or at maximum slip condition.

3 The thermostat may be fixed in the fully open position.

8.2.3.2 The electric drive train shall be supplied from a dc voltage source with a maximum voltage drop of 5 percent depending on time and current (periods of less than 10 s excluded). The supply voltage of the test shall be as specified by the vehicle manufacturer.

8.2.4 Testing the Vehicle on Chassis Dynamometer

8.2.4.1 While testing the vehicle on chassis dynamometer, the chassis dynamometer shall be adjusted for canceling the friction losses from the parts of the running vehicle other than the electric power train and the installed accessories. This may be carried out by calibrating the chassis dynamometer by coast down with the vehicle placed on the chassis dynamometer appropriately.

8.2.4.2 The power supply may be as given in **8.2.3.2** or may be from the traction battery of the vehicle. In such case, the voltage shall be maintained within the specified limits by supplying energy to the battery.

8.2.4.3 If the power supply is from the traction battery of the vehicle, the battery shall be charged according to the normal charge procedure for a period not exceeding 12 h or as per vehicle manufacturer's recommendation (*see 6.1.2.2.1*).

8.3 Test Procedure for the Motor Power

8.3.1 The test for determining the net power shall be carried out with the speed control set at the maximum position with full setting of the power controller.

8.3.2 Torque and speed data shall be recorded simultaneously.

8.3.3 If needed, the cooling liquid temperature recorded at the motor outlet must be maintained at $\pm 5^\circ\text{C}$ of the thermostat temperature setting specified by the manufacturer.

For air cooling drive trains, the temperature at a point indicated by the manufacturer shall be kept within ${}^{+0}_{-20}^\circ\text{C}$ of the maximum value specified by the manufacturer.

8.3.4 The temperature of the lubricating oil measured in the oil sump or at the outlet from the oil temperature exchanger (if any) shall be maintained within the limits prescribed by the manufacturer.

8.3.5 An auxiliary regulating system may be used, if necessary, to maintain the temperature within the limits specified in **8.3.3** and **8.3.4**.

8.4 Accuracy of Measurements

- a) *Torque*: ± 2 percent of measured torque. The torque measuring system shall be calibrated to take friction losses into account.
- b) *Vehicle Speed*: ± 1 km/h/engine speed ± 1 percent of measured speed.
- c) *Motor Inlet Air Temperature*: $\pm 2^\circ\text{C}$.

8.5 Determination of Net Power

8.5.1 The net power test shall consist of a run at full setting of the power controller.

8.5.2 Just before beginning the test, the vehicle/motor shall be run on the chassis/bench dynamometer for 3 min delivering a power equal to 80 percent of the rated maximum power at the speed recommended by the manufacturer.

8.5.3 Measurements shall be taken at a sufficient number of speeds (at least four) to define correctly the power curve between lowest and the highest speeds recommended by the manufacturer.

8.5.4 The whole test shall be completed within 10 min. It may be necessary to recharge the batteries once for completion of the power curve measurement.

8.6 Determination of Maximum 30 min Power

8.6.1 The electric drive-train/the battery operated vehicle shall be run on the bench dynamometer/chassis dynamometer at a power, which is declared by manufacturer for the maximum 30 min power. The speed is recommended to be in a range, at which the net power is greater than 90 percent of the maximum power measured in **8.5**. This speed shall be recommended by the manufacturer.

8.6.2 Speed and power shall be recorded. The power must be in a range of ± 5 percent of the power value at the start of the test. The maximum 30 min power is the average of the power within the 30 min period.

8.6.3 Test Results

The net power and the maximum 30 min power for battery operated vehicle indicated by the manufacturer shall be accepted if it does not differ by more than ± 5 percent for maximum power and more than ± 10 percent at the other measurement points on the curve with a tolerance of ± 1 km/h for

vehicle speed/ $\pm$ 1.5 percent of the motor speed, from the values measured by the Test Agency.

8.7 Measurement of 30 min Maximum Speed of the Vehicle

8.7.1 Power setting of the chassis dynamometer shall be as per the details given in 6.3.

8.7.2 At the start of the test the battery shall be charged as per 6.1.2.

8.7.3 The transmission ratio chosen, where applicable,

shall be that allows the highest speed of the vehicle. The vehicle shall be run on the chassis dynamometer at speed declared by the manufacturer for a period of 30 min.

At the end of 30 min the vehicle speed shall be within 5 percent of the speed declared by the manufacturer.

9 TECHNICAL SPECIFICATION

The manufacturer shall submit the technical specifications of the vehicle as given in Annex A while submitting for type approval.

ANNEX A

(Clauses 4.1 and 9)

TECHNICAL SPECIFICATIONS

A-1 GENERAL DESCRIPTION OF VEHICLE

- a) Vehicle model,
- b) Vehicle type, and
- c) Drawing and/or photographs of the vehicle.

A-2 DESCRIPTION OF THE TRACTION BATTERY

- a) Trade name and mark of the battery
- b) Kind of electro-chemical couple
- c) Nominal voltage, V
- d) Battery maximum 30 min power (Constant power discharge), kW
- e) Battery performance in 2 h discharge (Constant power or constant current)
 - 1) Battery energy, kWh
 - 2) Battery capacity, Ah in 2 h
- f) End of discharge voltage value, V
- g) Provision of ventilation for battery, Yes/No
 - 1) Brief description of the ventilation system adopted in the vehicle. Provide drawing if necessary.
 - 2) Brief description of the ventilation system adopted in the battery compartment. Provide drawing, if necessary.
- h) On-board indication of battery state of charge
 - 1) Details of indication when state of charge of the battery reaches a level when the manufacturer recommends recharging.

- i) Indication format
- ii) Relationship of state of charge indicator and the indication
- iii) Make
- iv) Model
- 2) Indication of state of charge of battery reaches a level at which driving vehicle further may cause damage to batteries
 - i) Indication format
 - ii) Relationship of state of charge indicator and the indication.
- j) Battery mass, kg
- k) Brief description of maintenance procedure, if any

A-3 DESCRIPTION OF THE DRIVE TRAIN

A-3.1 General

- a) Make
- b) Type
- c) Use: Mono motor/multi-motors (number)
- d) Transmission arrangement parallel/transaxial/others, to precise
- e) Test voltage, V
- f) Motor nominal speed, min^{-1}
- g) Motor maximum speed, min^{-1} or by default reducer outlet shaft/gear box speed (specify gear engaged)
- h) Maximum power speed, min^{-1}
- j) Maximum power, kW

- k) Maximum 30 min power, kW
- m) Maximum 30 min speed, km/h
- n) Flexible range (where $P > 90$ percent of maximum power)
- p) Speed at the beginning of the range, min^{-1}
- q) Speed at the end of the range, min^{-1}

A-3.2 Traction Motor

- a) Make
- b) Working principle
- c) Direct current/alternating current/number of phases
- d) Separate excitation/series/compound
- e) Synchron/asynchron
- f) Coiled rotor with permanent magnets/with housing
- g) Number of Poles of the Motor
- h) Motor power curve (kW) with motor rpm (min^{-1})/vehicle speed, in km/h

A-3.3 Power Controller

- a) Make
- b) Type
- c) Control principle: vectorial/open loop/closed/other (to be specified)
- d) Maximum effective current supplied to the Motor, A
- e) Voltage range use, V to V

A-3.4 Cooling System

- a) Motor: liquid/air
- b) Controller: liquid/air

A-3.4.1 Liquid Cooling Equipment Characteristics

- a) Nature of the liquid, circulating pumps, Yes/No
- b) Characteristics or make(s) and type(s) of the pump
- c) Thermostat: setting
- d) Radiator: drawing(s) or make(s) and type(s)
- e) Relief valve: pressure setting
- f) Fan: Characteristics or make(s) and type(s)
- g) Fan: duct

A-3.4.2 Air-cooling Equipment Characteristics

- a) Blower: Characteristics or make(s) and type(s)
- b) Standard air ducting
- c) Temperature regulating system, Yes/No
- d) Brief description
- e) Air filter: make(s) and type(s)

A-3.4.3 Maximum Temperatures Recommended by the Manufacturer:

- a) Motor outlet: °C
- b) Controller inlet: °C
- c) At motor reference point(s): °C
- d) At controller reference point(s): °C

A-3.5 Insulating Category: (IP)-Code:

A-3.6 Lubrication System Principle

- a) Bearings: friction/ball
- b) Lubricant: grease/oil
- c) Seal: yes/no
- d) Circulation: with/without

A-4 CHARGER

- a) Charger: on board/external trade-mark, model, rating
- b) Description of the normal profile of charging system
- c) Specifications of mains
 - 1) mains: single phase/three phase:
 - 2) Nominal voltage (V) & frequency (Hz) with tolerances:
- d) Reset period recommended between the end of the discharge and the start of the charge
- e) Recommended duration of a complete charge
- f) In case of on-board charger
 - 1) Continuous rating of charger socket (A):
 - 2) Time rating (h) of charger socket, if any:
 - 3) Whether soft-start facility Yes/No:
 - 4) Maximum initial in-rush current (A)

A-5 ELECTRICAL DETAILS OF VEHICLE FOR FUNCTIONAL SAFETY

- a) Schematic diagram showing the electrical layout giving all major electrical items along with their physical location in the vehicle. It shall include batteries, power-train components, protection fuses, circuit breakers etc
- b) Specifications of circuit breakers/fuses used for protection of batteries/power-train
 - 1) IS/IEC specifications
 - 2) Rating (A)
 - 3) Opening time (ms)
- c) Working voltage V
- d) Schematic highlighting physical location of live parts having working voltage greater than 60 V dc or 25 V ac
- e) Electric cables/connectors/wiring harness

- 1) IEC protection class
- 2) Insulation material used
- 3) Conduits provided, Yes/No
- f) List of exposed conductive parts of on-board equipment
 - 1) Any potential equalization resistance used to electrically connect these parts, Yes/No
 - 2) If yes, give details
- g) List of failures due to which the vehicle will come to standstill
- h) List of conditions under which the performance of vehicle is limited and how
- j) Declaration regarding design guidelines followed with respect to various requirements

A-6 ELECTRICAL ENERGY CONSUMPTION

Electrical energy consumption of vehicle, in W h/km.

ANNEX B

(Clause 4.3.1.7)

TEST PROCEDURE FOR PROTECTION AGAINST DIRECT CONTACTS OF PARTS UNDER VOLTAGE

B-1 PROTECTION PROVIDED BY AN ENCLOSURE AGAINST ACCESS TO HAZARDOUS PARTS

The protection of persons shall be given against,

- a) contact with hazardous low-voltage live parts;
- b) contact with hazardous mechanical parts; and
- c) approach to hazardous high-voltage live parts below adequate clearance inside an enclosure.

NOTE — This protection may be provided by means of the enclosure itself or by means of barriers as part of the enclosure or distances inside the enclosure.

B-2 TEST FOR PROTECTION AGAINST ACCESS TO HAZARDOUS PARTS

B-2.1 Access Probes

To verify the protection of persons against access to hazardous parts are given in Table 2.

B-2.2 Test Conditions

The access probe is pushed against any openings of the enclosure with the force specified in Table 2. If it partly or fully penetrates, it is placed in every possible position, but in no case shall stop face fully penetrate through the opening.

Internal barriers are considered part of the enclosure as given in the definition.

For tests on low voltage equipment, a low voltage supply (or not less than 40 V and not more than 50 V) in series with a suitable lamp shall be connected between the probe and the hazardous parts inside the enclosure.

Hazardous live parts covered only with varnish or paint, or protected by oxidation or by a similar process, are covered by metal foil electrically connected to those parts, which are normally live in operation.

The signal circuit method shall also be applied to the hazardous moving parts of high voltage equipment.

Internal moving parts may be operated slowly, where this is possible.

B-2.3 Acceptance Conditions

The protection is satisfactory adequate clearance is kept between the access probe and hazardous parts.

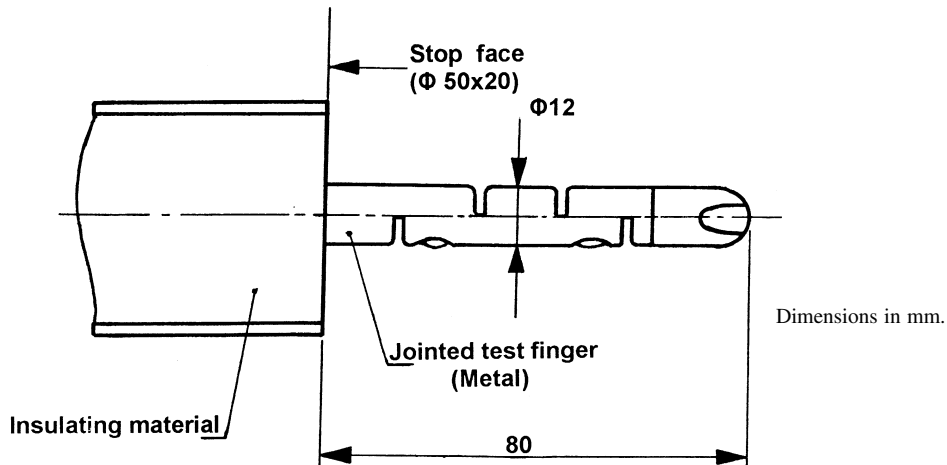
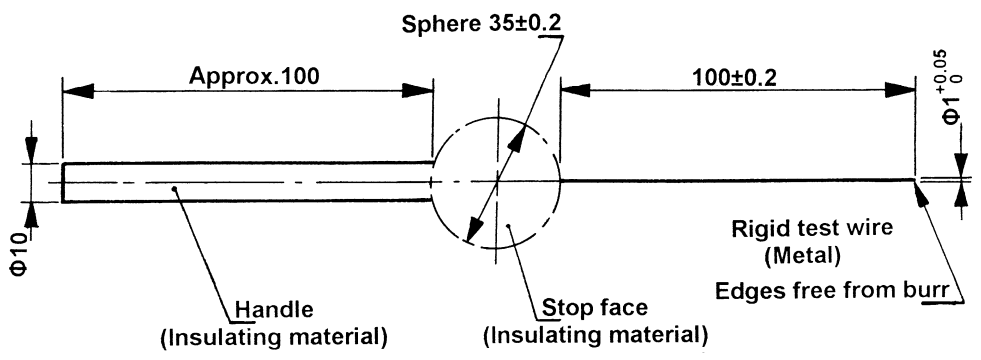
In the case of the test for the additional letter B, the jointed test finger (*see* Fig. 2) may penetrate to its 80 mm length, but the stop face (ϕ 50 mm $\times$ 20 mm) shall not pass through the opening. Starting from the straight position, both joints of the test finger shall be successively bent through an angle of up to 90° with respect to the axis of the adjoining section of the finger and shall be placed in every possible position.

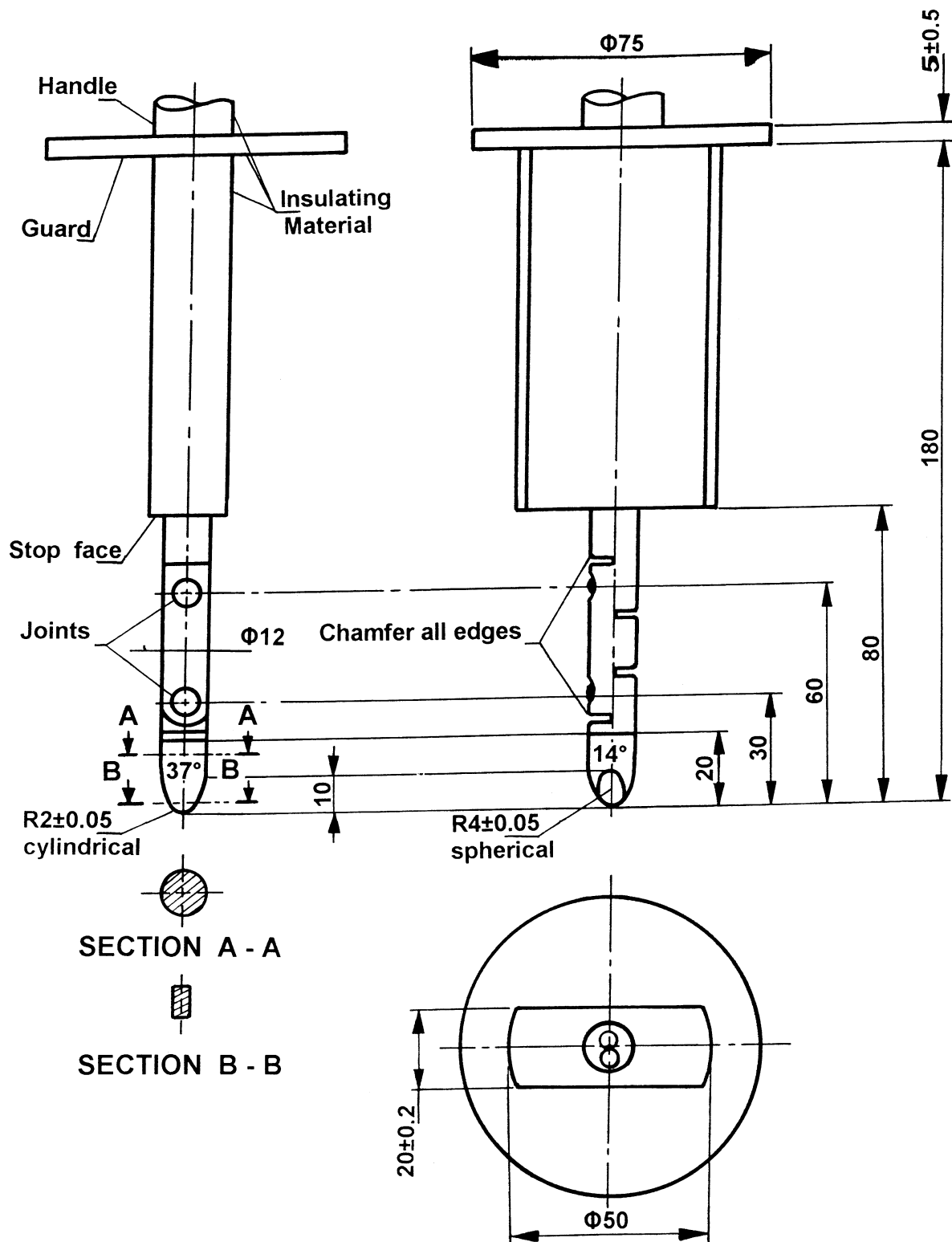
In case of the tests for the additional letter D, the access probe may penetrate to its full length, but the stop face shall not fully penetrate through the opening.

Conditions for verification of adequate clearance are identical with those given in **B-2.3.1**.

B-2.3.1 For low voltage equipment (rated voltages not exceeding 1 000 V ac and 1 500 V dc). The access probe shall not touch hazardous live parts. If adequate clearance is verified by a signal circuit between the probe and hazardous parts, the lamp shall not light.

Table 2 Access Probes for the Tests for Protection of Persons Against Access to Hazardous Parts
(Clauses B-2.1 and B-2.2)

SI No. (1)	Additional Letter (2)	Access Probe (3)	Force in N $\pm$ 10 Percent (4)
i)	B		10
ii)	D		1



All dimensions in millimetres.

FIG. 2 JOINTED TEST FINGER

ANNEX C
(Clause 4.3.3.2)

MEASUREMENT OF THE INSULATION RESISTANCE USING THE TRACTION BATTERY

C-1 DESCRIPTION OF THE TEST METHOD

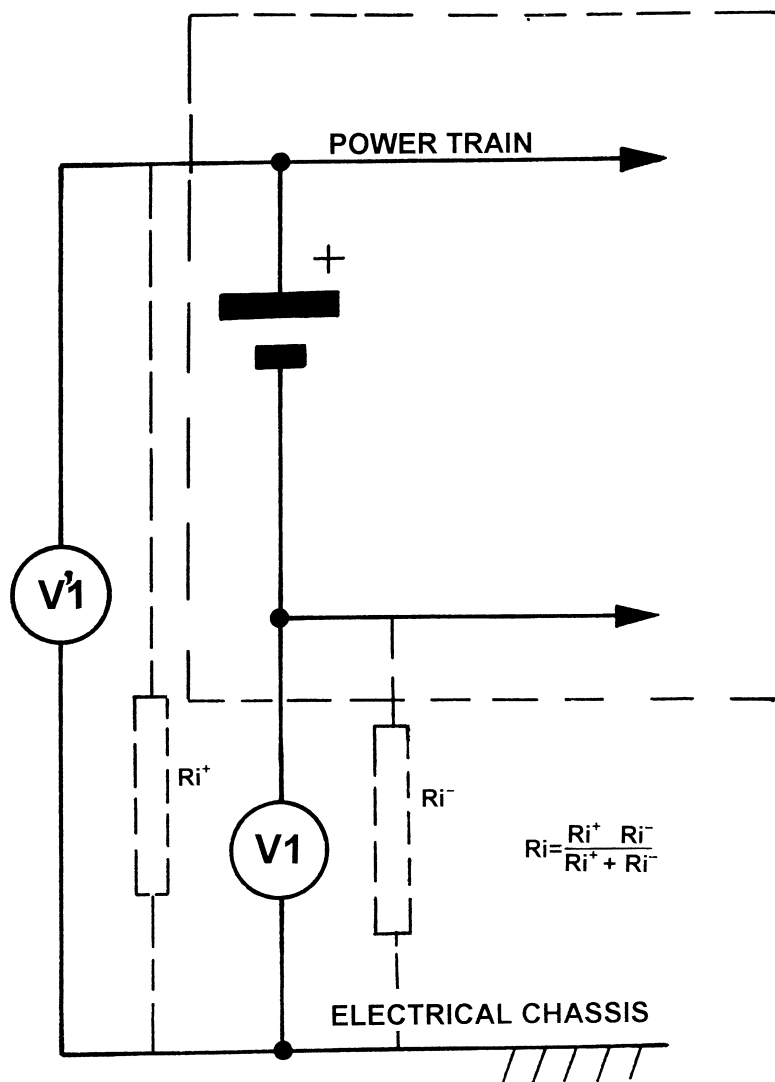
C-1.1 The traction battery shall be fully charged.

C-1.2 The voltmeter used in this test shall measure dc

values and have an internal resistance greater than 10 MΩ.

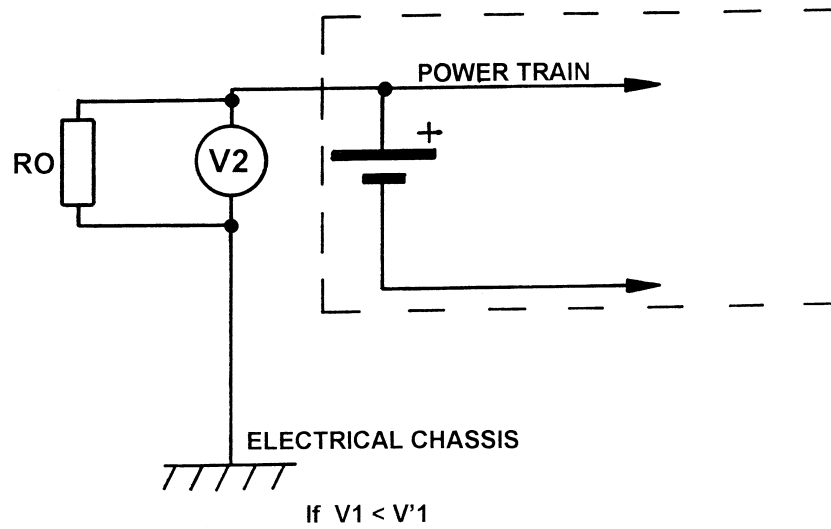
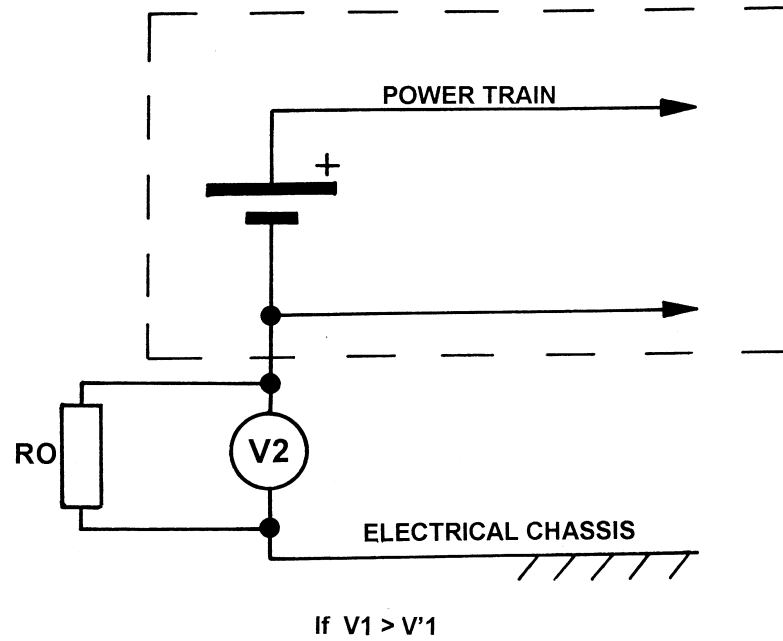
C-1.3 Measurement shall be made in following two steps.

a) STEP 1



Measure V1 and V1.

b) STEP 2



where RO is a resistance of $500 \pi/V$

The value of the insulation resistance Ri is given by one of the formula:

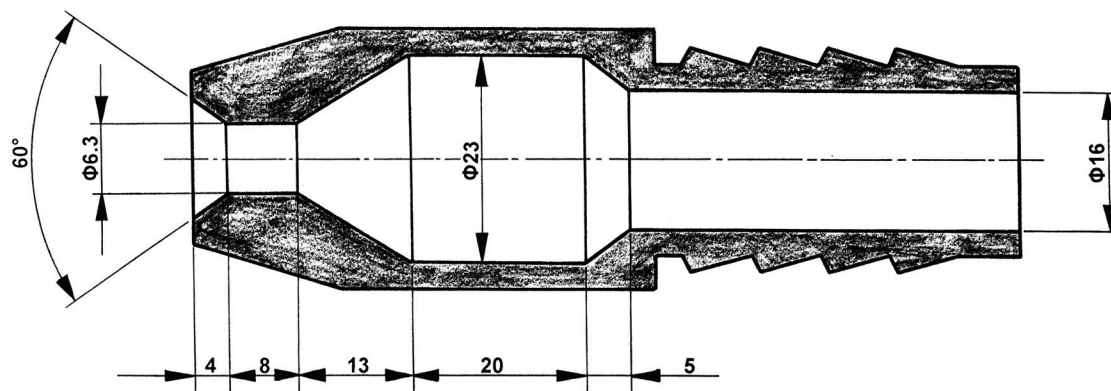
$$Ri = \frac{V_1 - V_2}{V_2} \times RO \quad \text{or} \quad \frac{V_1 - V_2}{V_2} \times RO$$

ANNEX D

(Clause 5.7.1)

HOSE NOZZLE

D-1 This Annex specifies dimensionally the hose nozzle as specified in IS 12063. nozzle (see Fig. 3) to be used for IPX5 test procedure



All dimensions in millimetres.

FIG. 3 HOSE NOZZLE DIMENSIONS

ANNEX E

(Foreword)

COMMITTEE COMPOSITION

Automotive Vehicles Running on Non-conventional Energy Sources Sectional Committee, TED 26

Organization	Representative(s)
Automotive Research Association of India, Pune	SHRI SHRIKANT R. MARATHE (<i>Chairman</i>)
Automotive Research Association of India, Pune	SHRI M. K. CHOUDHARI
	SHRI A. B. KOMAWAR (<i>Alternate</i>)
Ashok Leyland Ltd, Chennai	SHRI NIRMAL KUMAR
	SHRI G. VISWANATHAN (<i>Alternate</i>)
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	SHRI N. DASGUPTA (<i>Alternate</i>)
Bombay Environmental Action Group, Mumbai	SHRI DEBI GOENKA
Central Institute of Road Transport, Pune	SHRI G. K. SHARMA
	SHRI D. P. SASTE (<i>Alternate</i>)
Central Pollution Control Board, Delhi	SHRI T. VENUGOPAL
	SHRI RAJESH DEBROY (<i>Alternate</i>)

<i>Organization</i>	<i>Representative(s)</i>
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Hindustan Motors Ltd, Sagore	SHRI S. Y. RAO RTV-ENGG (GENERAL) (<i>Alternate</i>)
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Rutu Auto Gas Pvt Ltd, Ahmedabad	SHRI RAJESH KOTHARI
Sagas Autotech Pvt Ltd, Mysore	SHRI SANDEEP S. P. SHRI SANJAY SHYAMANUR P. (<i>Alternate</i>)
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Shri Shakti LPG Ltd, Hyderabad	SHRI JAYA PRAKASH RAMAPPA SHRI CHALAPATHY RAO (<i>Alternate</i>)
Society for Alternate Fuels Aftermarket Conversion, New Delhi	SHRI SANJAY GAMBHIR SHRI R. P. KHURANA (<i>Alternate</i>)
Society of Indian Automobile Manufacturers, New Delhi	SHRI K. K. GANDHI MS PAMELA TIKKU (<i>Alternate</i>)
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In personnel capacity (<i>D 606, Vashi Plaza, Sector 17, Vashi, Navi Mumbai 400705</i>)	SHRI ALOK CHANDRA GUPTA
BIS Directorate General	SHRI RAKESH KUMAR, Scientist F & Head (TED) [Representing Director General (<i>Ex-officio</i>)]

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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